

Actions Ongoing or Underway by NOAA Fisheries to Reduce Ship Strikes

Note: This white paper was developed within NOAA Fisheries as supporting documentation to provide explanation into the development of the operational measures in the proposed ship strike strategy. The paper should be considered a working document to be used as a tool for policy analysis and to further understand the origin of proposed measures. Comments on the document are welcomed, and may be sent to alera.jensen@noaa.gov.

NOAA Fisheries has an active program aimed at reducing the threat of ship strikes of North Atlantic right whales. This program includes several components. The agency has an active outreach and education program that includes a number of actions to alert mariners to right whale issues. NOAA has also conducted and funded research aimed at this problem, and worked cooperatively with other State and federal agencies to address collectively the ship strike threat. Since most of these actions are of an ongoing nature, they form an integral part of NOAA's overall ship strike reduction strategy. Details of some of the most important components of the action being taken are set forth below.

Aircraft and Vessel Based Surveys for Western North Atlantic Right Whales

To help reduce the likelihood of ship strikes, multi-agency teams designed surveys that transect key northern right whale feeding and calving areas during periods when the animals are expected to be present. Systematic surveys have been conducted in right whale habitat over waters off the Southeast United States (U.S.) since 1993, and since early 1997 in the Northeast U.S. Primary objectives of these surveys are to: 1) locate right whales and provide the location(s) to mariners in the area, 2) document evidence of interaction with fishing gear or ships, 3) record shipping traffic observed, and 4) photograph right whales for the purpose of photo-identification and enhanced life history information.

Due to concern over potential collisions between right whales and hopper dredges operating in the now-designated southeast critical habitat for right whales, monitoring requirements were placed on the Army Corps of Engineers (ACOE) and resulted, in the 1980s, in the first regular aerial survey flights for right whales in waters off the Southeast U.S. These surveys evolved over the years and, by late 1993-early 1994, were officially sponsored by NMFS, the Coast Guard (USCG), the Navy (USN), and the ACOE, and became known as Right Whale Early Warning System (EWS) surveys. The surveys were designed as daily surveillance flights to detect the presence of whales in and around a number of busy southeast shipping ports, USN vessel and submarine bases, and ACOE dredging sites, to alert vessels of the whales' presence, and to prevent potential whale/vessel collisions. The EWS, with the assistance of the USN and USCG, has evolved into a sophisticated communication network which alerts not only dredges and military vessels in the area, but provides sighting information to mariners via NAVTEX, NOAA Weather Radio, the Mandatory Ship Reporting System (MSR), other media, and even, in some situations, contacts vessels directly via radio to prevent imminent collision. Maps containing sighting information are emailed directly to dispatchers, harbor pilots, and other

marine interests. Maps with right whale sightings and survey information are posted on the Wheelock College WHALENET web site at: whale.wheelock.edu/whalenet-stuff/reportsRW_NE/.

Using the Southeast U.S. (SEUS) aircraft survey program as a model, efforts were initiated in late 1996 to develop a similar program in the Cape Cod Bay and Great South Channel critical habitats in late winter and early spring. This program is a cooperative effort by NMFS, the USCG, Massachusetts Division of Marine Fisheries (MA DMF), the Massachusetts Environmental Trust (MET), the Center for Coastal Studies (CCS), the USN, the ACOE Marine Traffic Controllers, and the Massachusetts Port Authority, or MASSPORT. A similar EWS, known as the Right Whale Sighting Advisory System (SAS), was established in the Northeast U.S. in late 1996. Sighting data from the SAS are distributed through faxes, email, multiple web sites, NAVTEX, NOAA Weather Radio, Cape Cod Canal Traffic Controllers, the MSR, shipping agents, pilots, dispatchers and other means to mariners and fishermen. This multi-source distribution network affords mariners the opportunity to have multiple sources for the whale location information, and to make necessary adjustments in shipping or fishing operations to decrease the potential for interactions. The USCG has played a key role in this effort, providing both air (1997 and early 1998) and sea support. The Commonwealth of Massachusetts was a key collaborator in the 1996-1997 effort and expanded the effort during subsequent survey seasons. Several states and the Canadian Department of Fisheries and Oceans (DFO) have expressed interest in conducting this type of SAS along their coastal waters. NOAA Fisheries has provided right whale funding to the states of MA, Rhode Island (RI), New York (NY), and Maine (ME) to develop right whale protection programs.

In the Northeast U.S., the primary source of information for the sighting network is dedicated aerial surveys conducted by NOAA Fisheries and the state of Massachusetts in the two critical habitat areas and beyond. Surveys occur each year from January to mid-July. Additional sighting information sources contributed throughout the calendar year are primarily opportunistic and include USCG aircraft and ships, ship-based sightings by several research organizations during their studies of right whales (Center for Coastal Studies, Woods Hole Oceanographic Institution, New England Aquarium, International Wildlife Coalition), research vessels, the Northeast Region Stranding Network, whale watch vessels, a high speed ferry and fishermen. Sighting locations are processed, disseminated, and faxed by NOAA Fisheries to a wide distribution network that includes federal and state agencies, shipping companies and agents and pilots, dispatchers, and right whale researchers. Email distribution of the right whale locations has been established to vessel masters and others to provide more timely distribution of the information. Right whale locations are broadcast to ships and other maritime users for a 24-hour period via USCG Broadcast Notice to Mariners, alerts on NOAA Weather Radio, and ACOE Traffic Controllers at Cape Cod Canal. Maps with right whale sightings and survey information are posted on the Wheelock College WHALENET web site at: whale.wheelock.edu/whalenet-stuff/reportsRW_NE/. Sighting information can also be found at the NOAA Fisheries Northeast Region, Northeast Fisheries Center and the Massachusetts Executive Office of Environmental Affairs web sites. All validated SAS sightings are also submitted to and incorporated in the return MSR North message to masters.

The Northeast Sighting Advisory System and the Southeast Early Warning System are

cooperative efforts by NOAA Fisheries, NOAA's National Weather Service, US Coast Guard, U.S. Navy, U.S. Army Corps of Engineers, Commonwealth of Massachusetts, the states of Georgia, Florida, and Massachusetts, Wheelock College, Massachusetts Environmental Trust, Center for Coastal Studies, New England Aquarium, NOAA's Stellwagen Bank National Marine Sanctuary, Massachusetts Port Authority, and the Naval Undersea Warfare Center Division, Newport, Rhode Island.

Additionally, NOAA Fisheries is funding aerial surveys in the Southeast U.S. to the South and North of the EWS surveys. These aerial surveys are conducted by the states of Florida and Georgia, respectively. NOAA Fisheries also funded aerial surveys along the mid-Atlantic states in 2000, 2001, and 2002.

Developing and Operating a Mandatory Ship Reporting System

In late 1997 and early 1998, the U.S. Government submitted a proposal to the International Maritime Organization (IMO) requesting implementation of a mandatory ship reporting system in right whale habitats in the Northeast U.S. and the Southeast U.S.. After approval by the Subcommittee on Safety of Navigation in July 1998 in London, it was adopted by the Maritime Safety Committee in December 1998. In early 1999, NOAA Fisheries worked with USCG personnel and a contractor to design the satellite-linked communication system and to help develop implementing regulations. MSR system operation began in July 1999. NOAA Fisheries and the USCG share the cost of operating the system. There is no cost to the mariner, and, other than reporting, the system makes no other requirements of the mariner.

Under the system, all ships greater than 300 gross tons entering the designated reporting areas off the north and south east coast (essential right whale habitat) are obligated to report location, speed, course, waypoints, and destination to a shore-based station. In return, all reporting ships receive a message describing the status, distribution, and behavior of right whales, as well as most recent sighting locations. The return message also advises mariners to assume whales will not avoid oncoming vessels, be alert for right whales, listen for broadcasts reporting recent right whale sighting locations, and reduce speeds be used when near whales or when traveling in critical habitats or in conditions of poor visibility. The northern portion of the system (WHALESNORTH) encompasses the right whale critical habitats in Cape Cod Bay and the Great South Channel and operates year round; the southern portion (WHALESSOUTH) includes right whale critical habitat off the southeast US and operates from 15 November to 15 April.

In 2000 NOAA Fisheries and a contractor, the Florida Fish and Wildlife Research Institute (formerly, Florida Marine Research Institute), began analysis of incoming messages from ships (e.g., ship destination, speed, and point of entry into the system) to assess ship volume, patterns, and speed in critical habitat. A report of this analysis was completed in 2002 and has been used to help facilitate development of further ship management options to reduce ship strikes (Silber et al., 2002).

The MSR System provides warnings to mariners entering right whale critical habitats about the presence of whale(s), raises the awareness of the industry about the vulnerability of

right whales to ship strikes, and provides ship traffic data for further assessment and development of options to reduce ship strikes. Design and operation of the system was a multi-organization effort, involving government and non-government organizations.

Updating Nautical Charts and Other Navigational Publications

To help ensure safe navigation in coastal waters of the U.S., the National Ocean Service (NOS) periodically publishes and updates nautical charts. NOS also issues a series of regional books called *Coast Pilots* which are references on navigation hazards, rules, and regional environmental conditions. In U.S. waters, all ship's captains are required to carry the *Coast Pilots*. NOAA Fisheries, NOS, and others have worked closely to update information printed on NOAA nautical charts and in *Coast Pilots* regarding right whale critical habitat, seasonal occurrence, the MSR, and regulations about approaching right whales and other protected marine species. *Coast Pilots* 1-4 covering waters off the entire eastern U.S. have been and will continue to be updated to include information on right whales, the threats posed to whales by ships, and measures mariners might take to avoid hitting right whales. Additionally, in cooperation with NOS, NOAA Fisheries has developed comprehensive extracts of all right whale information from *Coast Pilots* 1-4. These extracts are used as educational materials and provided to mariners via pilots and shipping agents. Nautical charts are updated on a schedule set forth by NOS. Reviewing and updating these publications should be done routinely, particularly in light of new measures identified by NOAA Fisheries to reduce ship strikes. NOAA Fisheries is also working with Coast Guard in District 1 to provide current sighting information and alerts on entangled right whales to the Local Notice to Mariners (LNM). LNM is published weekly and distributed to commercial and recreational vessels.

In 1998, NOAA Fisheries contacted the National Imagery and Mapping Agency's (NIMA) (formerly the Defense Mapping Agency) to request that its maritime publications be revised to include information on right whales and other endangered marine species. NIMA obliged and its publication, *Notice to Mariners*, now includes information on right whales and marine turtles. Working with NIMA, NOAA Fisheries updates the information annually. A similar request was made by NOAA Fisheries in 1999 regarding NIMA's *Sailing Directions*, which is prepared primarily for U.S. mariners sailing into international waters. Working with counterparts in Canada, NOAA Fisheries prepared information on right whales and precautionary measures for mariners for inclusion in *Sailing Directions*.

NOAA Fisheries and U.S. Coast Guard worked with British Admiralty (BA) Publications to incorporate detailed information on the Mandatory Ship Reporting System when shipping pilots pointed out that many masters use the BA publications. As a result, these publications contain regularly updated information on the vulnerability of right whales to ship strikes and precautionary measures mariners can take to avoid them.

International Safety Management Code

International Safety Management Code (ISM Code) of the Safety of Life at Sea Convention requires vessel companies and owners to develop procedures for safety of passengers and vessels at sea, including environmental protection measures and protocols. In late 1998 and

early 1999, NOAA Fisheries worked with the USCG to ensure that the implementing instructions and protocol include information on requirements and procedures regarding vessel operations consistent with protective measures for right whales and other protected marine species, including information important for voyage planning. The USCG agreed with the NOAA Fisheries recommendations and incorporated this information into the Coast Guard Marine Safety Manual (Commandant Instructions) on relevant guidance on vessel operations and voyage planning. These instructions require all U.S. flag vessels engaged in international voyages to maintain vessel safety management plans that include all precautionary measures (both domestic and international) for right whales and other marine mammals. Similarly, foreign flag vessels calling at U.S. ports must have a safety management plan that assures compliance with all international requirements, including the MSR system.

Education and Outreach

Several agencies and organizations have collaborated on developing and distributing brochures, pamphlets, placards, a right whale video, and informational materials to educate mariners about the vulnerability of right whales to ship strikes and the MSR system. These are being distributed by the USCG when ships are inspected port side, and by NOAA Fisheries to port authorities and shipping agents and companies, operation directors, cruise ship operators, dispatchers, and pilots' associations. The International Fund for Animal Welfare (IFAW) and NOAA Fisheries collaborated and developed a brief video in 1999 for mariners. This video has been well received by the industry, and provides background information on right whales, such as their behaviors, seasonal distribution, migratory patterns, and vulnerability to ship strikes. Such material should be reviewed and updated and a program for distribution of the material should be maintained.

The Northeast Region's Ship Strike Coordinator has been regularly attending port operator and harbor safety meetings throughout the northeast (Boston, Maine and New Hampshire, Rhode Island and Connecticut) for several years. The Coordinator is included on the port meeting agenda to provide an update on right whales. The Southeast Region's contracted shipping industry liaison has been attending similar industry-related meetings in the Southeast U.S. These meetings are extremely important for education and outreach. Additionally, the Northeast Region's Ship Strike Coordinator has arranged for Coast Guard boarding inspectors and shipping industry personnel to observe on SAS aerial surveys to get a better understanding of the agency's right whale ship strike reduction efforts.

Pilots from the port of Boston have voluntarily worked with masters for the last two years to improve compliance with the Mandatory Ship Reporting System by checking to see if messages have been sent and received by masters entering Boston and by providing MSR placards to masters. Additionally, pilots from several Northeast and Southeast ports have distributed packets of information on right whales and ship strike issues to masters. Pilots in the NE have also recorded this distribution on spreadsheets that they are maintaining. These spreadsheets have provided some feedback to NOAA Fisheries as to the level of awareness mariners have on right whale issues. In 2004, NOAA Fisheries recognized the Northeast Marine Pilots Association for their extensive outreach and educational work with a NOAA Environmental Hero Award.

Northeast Region's ship strike reduction outreach has included working with Bath Iron Works (BIW) in Maine which builds Navy destroyers. The BIW destroyers are tested in sea trials that occur along the east coast in the Gulf of Maine, the Great South Channel and mid-Atlantic where right whales occur and migrate. NOAA Fisheries and a contractor working on ship strike reduction measures for the Northeast Regional Office (NER) briefed BIW senior management Navy personnel (June 2000) on the issues of right whales and their vulnerability to ship strikes. Additionally, similar right whale briefings have occurred at Brunswick Naval Air Station in Maine (June 2000 and January 2004) to provide Naval aircraft personnel conducting various training exercises over the Gulf of Maine with information on the status and distribution of right whales in their areas of operation. These types of briefings are vital to the conservation of right whales.

Regional Recovery Plan Implementation Teams

The Endangered Species Act (ESA) provides authority to the Secretary of Commerce (*i.e.*, NOAA Fisheries) to establish teams to assist in implementing recovery plans by reviewing recovery activities and providing recommendations to NOAA Fisheries on improving such activities. NOAA Fisheries established two such teams, one in the southeastern U.S. and one in the northeastern U.S., to address the known impacts to right (and, in the NE, humpback) whales described in the Recovery Plans. The Implementation Teams provide advice to NOAA Fisheries and other federal and state agencies or private entities on achieving these national goals within their respective regions. The Southeast Team focuses primarily on vessel-related issues and the Northeast Team focuses on both vessel-related issues and habitat related issues. Both Teams rely on the take reduction plan process under the Marine Mammal Protection Act (MMPA) for reducing takes in commercial fisheries.

In 2004, the Northeast Implementation Team (NEIT) re-structured to focus their efforts solely to ship strike reduction efforts and to support the NOAA Fisheries Strategy to Reduce Ship Strikes of Right Whales. The NEIT consists of representatives from NOAA Fisheries (Northeast Regional Office and Science Center); the U.S. Coast Guard (USCG); Canada Department of Fisheries and Oceans; U.S. Navy; New England Fisheries Management Council; Massachusetts Divisions of Fish and Wildlife; Massachusetts Water Resource Authority; Environmental Protection Agency; Marine Mammal Commission; Massachusetts Coastal Zone Management; Maine Department of Marine Resources; Stellwagen Bank National Marine Sanctuary, and the MASSPORT Maritime Department.

The NEIT meets regularly and provides recommendations or guidance to NOAA Fisheries and other agencies with regard to reducing the co-occurrence of right whales and ships, and supports projects that provide additional information and documentation in support of the NOAA Fisheries Strategy to Reduce Ship Strikes of Right Whales. The team and its participating agencies have also had important roles in the aerial survey and communication system (SAS) described above. In addition, in response to current needs, the NEIT established a separate ship strike committee to address these impacts on a more formal basis. The committee's role was very contributory to ship strike efforts, and as a result, NOAA Fisheries determined it appropriate to focus the Team's efforts exclusively on ship strike reduction and whale avoidance.

The Southeastern U.S. Implementation Team (SEIT) established in August 1993 consists of representatives from the Georgia Department of Natural Resources; the Florida Fish and Wildlife Conservation Commission; NOAA Fisheries Southeast Fisheries Center and Southeast Regional Office; U.S. Navy; Marine Mammal Commission; Georgia Ports Authority; Canaveral Port Authority; Glynn County Commission, Glynn County, GA; University of Georgia; U.S. Army Corps of Engineers; U.S. Environmental Protection Agency; Port of Fernandina, Fernandina, Florida; the U.S. Coast Guard (USCG), and the Jacksonville Port Authority.

The SEIT has met regularly since being established and, among other things, has worked to develop and implement a system of aerial surveys to detect and report the locations of right whales to mariners. Members of the SEIT have also implemented a multi-agency effort to provide a local Notice to Mariners broadcast about right whale calving grounds which is broadcast four times daily by the USCG on VHF radio. The SEIT also makes recommendations to NOAA Fisheries and other agencies regarding such things as right whale research and measures to reduce the possibility of ship strikes, and restrictions of hazardous fishing gear in right whale calving areas. The SEIT established a GIS subcommittee in the late 1990s and is analyzing right whale sightings, vessel traffic information, and pertinent environmental data to better understand right whale distribution patterns in southeast waters and ultimately prevent human interactions with these whales.

With the annual support of the SEIT and NOAA Fisheries, the Right Whale Newsletter is published quarterly as a source of news, updates, and lists of recent publications for the right whale community. This newsletter is distributed gratis to all interested parties. Another outreach project of the Southeast Implementation Team is the development and production of a right whale-related multi-media cd-rom for distribution to mariners frequenting U.S. East Coast ports. The cd will provide information on right whales and the MSR, tools for submitting successful reports to the MSR, and other information of interest to the mariner.

Recently, both Teams have focused on reducing ship strikes. NOAA Fisheries should continue to support the work of these Teams in helping to implement right whale ship strike reduction strategies.

Interagency Consultation Under the Endangered Species Act

In the last several years, NOAA Fisheries has conducted consultations on the activities of a number of U.S. fisheries and ship operations by federal agencies that have resulted in various types of modifications of fishing operations and vessel operating procedures. Consultations include Biological Opinions on (a) USCG vessel operations and other activities in 1995 and 1996; (b) US Navy activities in 1997; (c) the American Lobster Fishery in 1996; (d) the Northeast Multispecies Groundfish Fishery in 1996; (e) the Atlantic Fisheries for Highly Migratory Species in 1997; (f) Northeast Multispecies Sink Gillnet Fishery in 2001; (g) Monkfish Fisheries in 2001; (h) Spiny Dogfish Fisheries in 2001; and (i) Lobster Trawl Fisheries in 2001.

Section 6 Cooperative States Programs

Section 6 of the ESA authorizes the Secretary of Commerce to enter into cooperative agreements with states that establish and maintain an adequate and active program for the conservation of endangered and threatened species. The section 6 agreements may provide a means for the transfer of some management authority from the federal government to state agencies with the responsibility to protect threatened and endangered species. In addition, those states that enter into these agreements may be provided with financial assistance to support the development of state programs for the conservation of endangered and threatened species and to monitor the status of candidate and recovered species. Currently, the Northeast Regional Office has three active and formal section 6 agreements within the Northeast Region – Massachusetts, New York and Maryland. The Southeast Regional Office has four active and formal section 6 agreements: Florida, Georgia, South Carolina, and North Carolina.

Five areas of emphasis are suggested and recommended with priority given to state projects that cooperate with industry toward real solutions:

1. Ship strike mitigation to reduce right whale interactions via technology or other acceptable means, developing better understanding of right whale behavior and responses to approaching vessels, and development of merchant mariner training curriculum;
2. Enforcement as it applies to individual or cooperative states;
3. Gear investigation and testing to reduce entanglement;
4. Disentanglement activities which will reduce mortality and/or serious injury of entangled whales; and
5. Education and outreach programs to fishermen, mariners, recreational vessel operators (commercial and private), and the general public to facilitate reduction of gear interactions.

A number of states have been awarded Section 6 grants for various projects. These include:

1. Maine Department of Marine Resource: Cooperative Management Plan for Large Whales and Sea Turtles in the State of Maine
2. South Carolina Department Natural Resources: Monitoring North Atlantic Right Whales off the Coast of South Carolina and Georgia
3. Massachusetts Division of Marine Fisheries: Massachusetts Right Whale Conservation Plan
4. New York Fish and Game [The Riverhead Foundation for Marine Research and Preservation]: Aerial Survey for Marine Mammals New York Bight
5. Florida Fish and Wildlife Conservation Commission: North Atlantic Right Whale Informational Signs for Recreational Mariners
6. Georgia Department of Natural Resources: Right whale recovery activities and DTAG study to monitor behavior of right whales

NOAA Fisheries-Supported Research Activities

Right whale research and management activities within NOAA Fisheries have been funded by Congress since 1986. Initial appropriations totaled \$500,000 in FY1986, and

\$200,000-\$250,000 annually for FY1987-1997. Congressional funding for right whales increased to \$350,000 in FY1998, with a NOAA Fisheries supplement to bring the total to about \$1.0 million. In FY1999, appropriations increased to \$1.0 million and NOAA Fisheries supplemented this to a total of about \$1.4 million. In recent years, appropriated amount has increased substantially as follows: \$4.1 million in FY2000; \$5.0 million in FY2001 (with \$2.9 million going to the Northeast Consortium and \$2.1 million going to NOAA Fisheries); and \$6.9 million in FY2002 (with \$1.0 million going to the Northeast Consortium and \$1.5 million going to support State run programs). In FY2003, Congress appropriated \$10.0 million for right whale recovery actions; and in FY2004, the appropriated amount increased to \$12.056 million.

In addition to supporting or implementing a number of recovery actions discussed above such as aerial surveys to provide right whale sighting locations to mariners, operation of the Mandatory Ship Reporting System and analysis of data from the system, enforcement of fishing regulations, and vessel surveys for population assessment, NOAA Fisheries supported a number of right whale research and data curation activities in recent years. A brief description of these activities follows.

Photo-Identification and Sighting Data Bases

Photo-identification of individual whales is perhaps one of the best ways to monitor trends in North Atlantic right whale abundance and demography. Photographic data, and associated sighting data, provide information on individual longevity, social interactions, habitat use, calving history, movements and migrations. Ongoing analysis of these data and collection of new photos are central to a range of right whale science and management goals. A long-term photo- identification database is currently maintained, newly collected information added cumulatively, and data analyses provided to collaborating investigators. NOAA Fisheries annually supports photo-identification studies and ongoing maintenance and curation of the database of right whale sightings.

As noted above, NOAA Fisheries and other agencies support aerial surveys for right whales, primarily to reduce the likelihood of ship strikes by identifying whale locations for mariners. These surveys also provide individual whale photo-identifications. Each year, the SAS and EWS programs and their numerous partners, as well as photos provided by field researchers, contribute a substantial number of the photo-identification data.

As with the photo-catalogue, the North Atlantic Right Whale Sighting Database represents an essential resource that underpins much of the fundamental analysis of this population. The data base is curated at the University of Rhode Island and includes all archival right whale sighting records. New sighting data, provided from many sources, are added annually. Funding for continued maintenance of the database as well as for production of a much-needed sightings-per-unit-effort analysis of existing data therein is expected to be ongoing.

Satellite Tracking, VHF Radio Tracking, and Acoustic Tagging Studies

There is a general lack of information on where a substantial portion of the western North Atlantic population over-winters. Also, information about habitat use and specific behavior in

certain areas is incomplete. In addition, little is known about whale reaction to oncoming ships and why the species is vulnerable to collisions with ships. In the last two decades, tools have been developed to help address these and other basic questions about right whale movement, migrations, habitat use, residency and behavior. These include devices attached to right whales and other marine mammals such as satellite tags, very high-frequency (VHF) radio tags, time-depth recorders, and acoustic tags. **Satellite tags** have long duration, provide information on whale locations mediated through satellites and can help assess long distance movement of right whales. **VHF radio tags** are typically tracked from a ship or aircraft, have short range (e.g., kilometers or tens of kilometers) and provide relatively fine scale movement (e.g., habitat use), information on dive times, and surface behavior, and have the advantage of providing location data around the clock when visual studies are not possible. **Time-depth recorders** provide a record of whale movement and behavior while at depth, and can provide insight about reaction to human stimuli and environmental features. Recently developed **acoustic tags** have been coupled with time-depth recorders to provide information on sound signals produced and received by a tagged whale. These tags are generally short duration (attached with a suction cup), benign tags that can be used to assess whale reaction to various sound sources. In response to the need to address basic uncertainties about whale behavior and biology and given development and refinement of tools (e.g., tags) to address them, NOAA Fisheries supported a number of studies using these tools to address the uncertainties.

In the past, NOAA Fisheries provided support for VHF-radio tagging and tracking studies of right whales in the southeast US critical habitat. The purpose was to provide data for evaluation of the size of Florida/Georgia calving ground critical habitat, further quantify dive time characteristics, further assess the probability that an individual would be sighted by an observer on a ship or aircraft, and where possible provide individual whale sighting locations to transiting ships. Pilot field studies began in 1999 to assess right whale fine-scale movements and submergence times. The goal was to expand this study in southeast US waters in 2000 by using implantable tags. Unfortunately and unexpectedly, very few whales occurred in these waters in winter/spring 2000, one of the lowest calving years on record. While biologists were ready to conduct the tagging work, no tags were deployed.

In conjunction with the Office of Naval Research, NOAA Fisheries supported a large scale satellite tagging program in 2000. The tags are capable of remaining on the whale for up to several months and the goal was to attach tags to right whales leaving summer/fall feeding grounds and to track their movements for as long as possible. In addition, concurrent assessment of oceanographic parameters and prey density and distribution was conducted to help quantify environmental factors that dictate right whale occurrence and distribution. Such data are vital to understanding habitat use and will provide important information to predictive modeling exercises (see below), which will help in identifying actions aimed at reducing impacts from the shipping and fishing industries. In summer 2000 a total of 16 tags were attached in the Bay of Fundy and those tagged whales were tracked for a total of 396 days. One whale, an adult female, was tracked for 130 days throughout waters off New England, across major shipping lanes, and then directly to the southeast US calving ground. Whale locations were provided to the NOAA Fisheries Sighting Advisory System to be relayed to mariners in the vicinity. Oceanographic data, including right whale prey distribution data, were collected throughout the Bay of Fundy and Scotian Shelf coincident to the tagging work. Two whales tagged had not been previously

identified or photographed and the satellite tracks indicated that these whales ranged widely, traveling great distances in relatively short times. Both the shipping and fishing industries have been very supportive of this tagging work since it has potential to provide important information on right whales and their movements. While these results were promising, a technical problem with the tag's antenna prevented collection of further data in 2001. Results from an improved tag used on South Atlantic right whales have been encouraging.

For several years running, NOAA Fisheries has provided funding for a study of right whale behavior using acoustic tags and time-depth recorders (TDR) tags. This tag collects a variety of data, including three-dimensional orientation and movement of the whale, dive depth. The tag also records ambient noise and thus provides critical information on what the right whale is hearing as it responds (or does not respond) to the sounds of approaching ships. The tag was successfully tested in 1999 and was deployed in a series of playback and other experiments in the Bay of Fundy in the summers of 2000, 2001, 2002, 2003, and 2004. This is promising work and support should likely continue pending recent results of this effort.

Detecting Whales at Sea

It is possible that the risk of ship strikes could be reduced if ways were found to improve detection of whales at sea. A number of techniques are being studied to assess their feasibility and capabilities at detecting whales. Among these are (a) "active acoustics", (b) "passive acoustics", and (c) enhanced visual detection. Active acoustic studies use SONAR or sound producing devices that identify an entity in the water based on the returning echo. In 2000 NOAA Fisheries provided funding for a pilot study of an active acoustic sensing device, or forward looking sonar. This work is ongoing and the device is being refined and improved. Similarly, studies were funded of passive acoustic devices – that is, listening devices used to detect and locate whales based on the vocalizations they emit. These passive acoustic studies were conducted in Cape Cod Bay and the Great South Channel in 2000, 2001 and 2002.

Finally, NOAA Fisheries supported work in 2000 to study the feasibility of using an infrared video device to detect whales at the surface based on heat emitted from the animal's body or contained in its exhalation. Support of this type of work is expected to continue.

Predictive modeling

NOAA Fisheries convened a workshop in October, 1998 in Woods Hole, Massachusetts to evaluate the possibility of predicting right whale occurrence based on environmental data, with sufficient reliability to be of use in management and conservation of the species. The workshop concluded that given certain, measurable environmental features (e.g., prey distribution and oceanographic factors that influence prey distribution), it may be possible to assess where right whales are likely to occur. If so, reduction of adverse effects from human activities, including ship strikes, may be enhanced. NOAA Fisheries has provided support of studies to examine correlations between right whale distribution and environmental data (notably on sea surface temperature); however, results of the latter study have not been conclusive. Development of a predictive system would be extremely useful in crafting and implementing management measures to mitigate human-related conflicts.

GIS Analyses

Geographic Information Systems (GIS) may be one of the most important tools for providing descriptions of right whale distribution -- particularly relative to environmental features -- assessing critical habitat boundaries, and other analyses. In 1999 and 2000 funds were provided to construct and maintain a right whale GIS with the Florida Fish and Wildlife Conservation Commission (FWC). An important focus will be the development of a predictive model of right whale habitat use and movements to determine where right whales would most likely occur in a given period. The GIS analysis would complement existing and ongoing right whale research by building and maintaining right whale specific and ancillary environmental spatial data sets; compiling data on vessel traffic from aerial surveys and the Mandatory Ship Reporting system; and analyzing these data to evaluate right whale critical habitat boundaries, sightings of known right whales for site fidelity, existing ship traffic patterns and routes, other factors influencing habitat use, and whale habitat use patterns. Ultimately, these data will be used to perform risk analyses to aid decision-makers in determining how best to protect right whales in US waters. This type of work will yield productive results and support should continue.

Literature Cited

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